



# Lake Shore

## CRYOTRONICS



PRODUCT GUIDE

Since 1968, Lake Shore Cryotronics has been your trusted source for high-performance cryogenic and Hall sensors and instruments. Our sensors are available accurately calibrated in value-added packaging, and we offer high-performance instruments, both to go along with our sensors, but also to source and measure electronic signals.

With the addition of our MeasureLINK™ software, any combination of our products can become a characterization system, or you can choose from our turnkey line of Hall systems, electromagnet platforms, and VSMs.

Lake Shore is a well-respected name with worldwide sales, distribution, and service to the physics research community. We are here to help you measure more in less time!



## Cryogenic temperature measurements

- Temperature sensors
- Temperature probes
- Temperature controllers
- Temperature monitors
- Installation accessories
- MeasureLINK software



## MeasureReady electronic measurements

- Current sources
- Synchronous source measure system
- FastHall™
- MeasureLINK software



## Magnetic measurements

- Hall sensors
- Hall probes
- Teslameters and gaussmeters
- Fluxmeters
- Helmholtz and search coils
- Magnetic accessories
- MeasureLINK software



## Device and material characterization

- MeasureLINK software
- Cryogenic environments by Janis
- Cryogenic probe stations
- Electromagnets
- Modular characterization systems
- Hall effect systems
- Vibrating sample magnetometers
- Power supplies
- Recirculating chillers

# Cryogenic Temperature Measurements



## Cryogenic Temperature Sensors

Measure from <math><10\text{ mK}</math> to over 1,500 K using our comprehensive line of sensors. Industry-leading sensors include Cernox<sup>®</sup> thin-film RTDs featuring low magnetic field-induced errors and excellent stability over repeated thermal cycling and under extended exposure to ionizing radiation. Others include silicon diode, germanium, and ruthenium oxide (Rox<sup>™</sup>) sensors as well as platinum RTDs and specialty sensors with NIST-traceable calibrations.



## Cryogenic Temperature Probes

Ideal for measuring inside fluid containers, cryostats, and other liquid storage systems, these probes provide highly reliable sensor performance in a thermowell or direct cryogen contact. Customizable for specific applications, probes can be configured with many sensor types for superior performance from room temperature to 4 K and below.



## AC Resistance Bridges

Optimized for measurement and control of dilution refrigerators operating below 100 mK, AC resistance bridges make it easy to perform multiple tasks that were once very difficult to perform reliably at sub-1 K ranges: temperature measurement, automatic or manual temperature control, and device or sample impedance measurements.



## Controllers, Monitors, and Sources

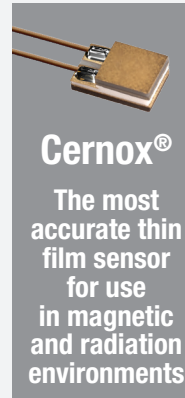
Our temperature instruments measure multiple sensors and sensor types in applications requiring high sensitivity at ultra-low temperatures. Controllers are available with up to eight inputs and four independent control outputs, and monitors come with up to 12 independent sensor channels. Our DC current source provides stable currents for test and measurement applications.



## Temperature Sensor Input Modules

For precision remote monitoring of sensors used in large-scale cryogenic facilities down to 1 K, Lake Shore offers multi-input modules that enable reliable real-time monitoring over PLC-based networks.

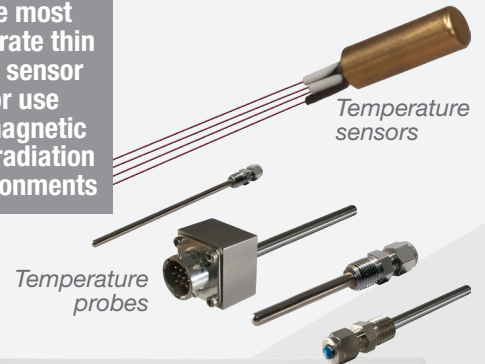
**Also available:** Cryogenic accessories (cable, wire, grease, varnish, and more)



**Cernox<sup>®</sup>**  
The most accurate thin film sensor for use in magnetic and radiation environments

**HR** HIGH RELIABILITY SERIES

High reliability cryogenic temperature sensors for mission-critical applications



Model 372 AC resistance bridge



Model 335 controller



Model 121 current source



Model 336 controller



Model 240-8P cryogenic temperature sensor input module

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# Magnetic Measurements



## Teslameters/gaussmeters

Measure both DC and AC magnetic fields and control DC fields with these highly accurate instruments. Ideal for both industrial QC and scientific R&D applications, gaussmeters offer a broad measurable field range (from 1 mG to 350 kG) in an easily programmable instrument.



F71 3-channel teslameter

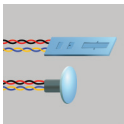


## Hall Probes

Lake Shore offers a number of Hall probes with axial, transverse, multi-axis, and tangential field orientation for measuring magnetic flux density. Choose from high-stability, high-sensitivity, and ultra-high-sensitivity types in a wide range of lengths and thicknesses. Hall probes are also available for cryogenic applications.

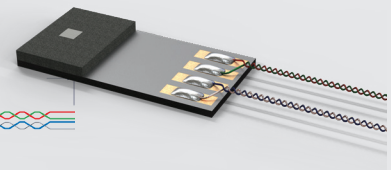


Hall probes



## Magnetic Sensors

We offer compact Hall sensors for reliably measuring magnetic field magnitude in axial or transverse configurations. Available with 4-lead cable assemblies, Hall generators can be ordered in general purpose and instrumentation quality packages for either surface- or channel-mount applications. Cryogenic Hall sensors are also available.



Hall sensors



## Fluxmeters

Measure total flux in industrial and research measurement system settings, such as in BH loop or hysteresisgraph measurement applications. Our fluxmeters feature compensated analog integration for faster instrument response than those with digital circuitry alone.



Model 480 fluxmeter



## Helmholtz Coils, Field Standards, and Search Coils

For producing moderate-volume uniform magnetic fields, our Helmholtz coils are available with standard field or magnetic moment measurement capabilities. We also offer field probes for search coils when measuring in narrow gaps or where field gradients require the use of smaller coil diameter.



Helmholtz and search coils

**Also available:** Magnetic accessories (reference magnets, extension cables, and more)



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**Measure Ready**



## MeasureReady® instruments for materials characterization

### 155 AC/DC current and voltage source— DC-low noise performance without compromising AC bandwidth

The low-noise MeasureReady 155 precision current and voltage source combines premium performance with unprecedented simplicity for materials scientists and engineers requiring a precise source of voltage and current.



- Low RMS noise: from 200 nV (10 mV)/7 pA (1  $\mu$ A)
- Bipolar, 4-quadrant power source
- DC and AC modes supported up to 100 kHz (155-AC only)
- Full scale ranges—voltage: 10 mV to 100 V, current: 1  $\mu$ A to 100 mA
- 0.001% programming resolution (from 100 nV/10 pA)
- In-phase reference output for use with a lock-in amplifier (155-AC only)
- Manual and autorange function
- Front and rear input connectors
- Touchscreen user interface
- USB and LAN connectivity (GPIB option)
- 3-year standard warranty

### M91 FastHall™ measurement controller—a new approach to Hall measurement

The MeasureReady M91 is a revolutionary, all-in-one Hall analysis instrument that delivers significantly higher levels of precision, speed, and convenience to researchers involved in the study of electronic materials.



#### Simpler and more convenient

- All-in-one instrument
- Automatically selects optimal excitation and measurement levels
- Automatically executes measurement steps
- Provides complete Hall analysis
- Easy to integrate with lab systems

#### Makes better measurements, faster

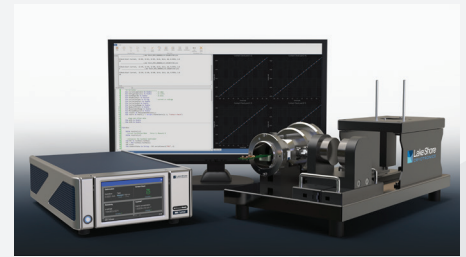
- No need to reverse the magnetic field with FastHall
- Up to 100× faster for low-mobility materials
- Improves accuracy by minimizing thermal drift

#### Cost effective

- Build a new Hall system or upgrade an existing one
- Add state-of-the-art Hall measurement capability to any lab
- Use with any type of magnet

## FastHall measurement capability contained in a complete characterization platform

### MeasureReady FastHall Station



- Proprietary FastHall technology enables low-mobility measurements without field reversal in seconds
- Mobility measurements down to 0.01  $\text{cm}^2/\text{V s}$  for van der Pauw samples with resistances from 10 m $\Omega$  to 1 G $\Omega$
- Completely guarded triaxial cabling to fully shielded, insertable, light-tight sample chamber plus an LN<sub>2</sub> option
- MeasureLINK-MCS software provides standard sequences, charts, exportable reports and user customizable scripts
- Easy to use spring pin and solder sample holder cards accommodate up to 10 mm  $\times$  10 mm van der Pauw and Hall bar type samples
- Measurement times greatly reduced through patented FastHall method
- Available gate bias instrument option and ability to easily integrate third-party sources and instruments
- Simple, repeatable, and reversible permanent magnet with nominal fields of 1 T and optional 0.8 T for LN<sub>2</sub>

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# M81-SSM Source Measure System







An innovative instrument architecture optimized to provide **synchronous** DC, AC, and mixed DC+AC source and measure to 100 kHz for low-level measurements



The MeasureReady™ M81-SSM (Synchronous Source and Measure) system provides a confident and straightforward approach for advanced measurement applications. The M81 is designed to eliminate the complexity of multiple function-specific instrumentation setups, combining the convenience of DC and AC sourcing with DC and AC measurement, including a lock-in's sensitivity and measurement performance.

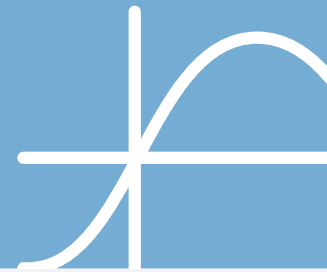
This extremely low-noise simultaneous source and measure system ensures inherently synchronized measurements from 1 to 3 source channels and from 1 to 3 measure channels per half-rack instrument—while also being highly adaptable for a range of material and device research applications.

Learn more at [www.lakeshore.com/m81](http://www.lakeshore.com/m81)

-  **Unique real-time sampling architecture for synchronous sourcing and measuring**
-  **Ideal for scientific-grade low-level measurement applications**
-  **The absolute precision of DC plus the detection sensitivity performance of AC instrumentation**
-  **Remote-mountable modules are interchangeable between instruments**

Timing is everything.

Now it's automatic.



MeasureLINK™-MCS software

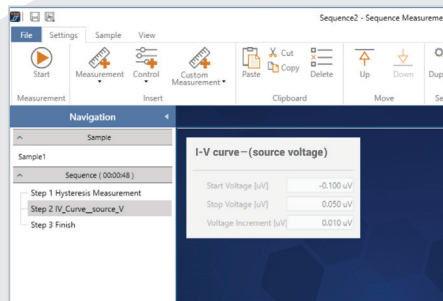
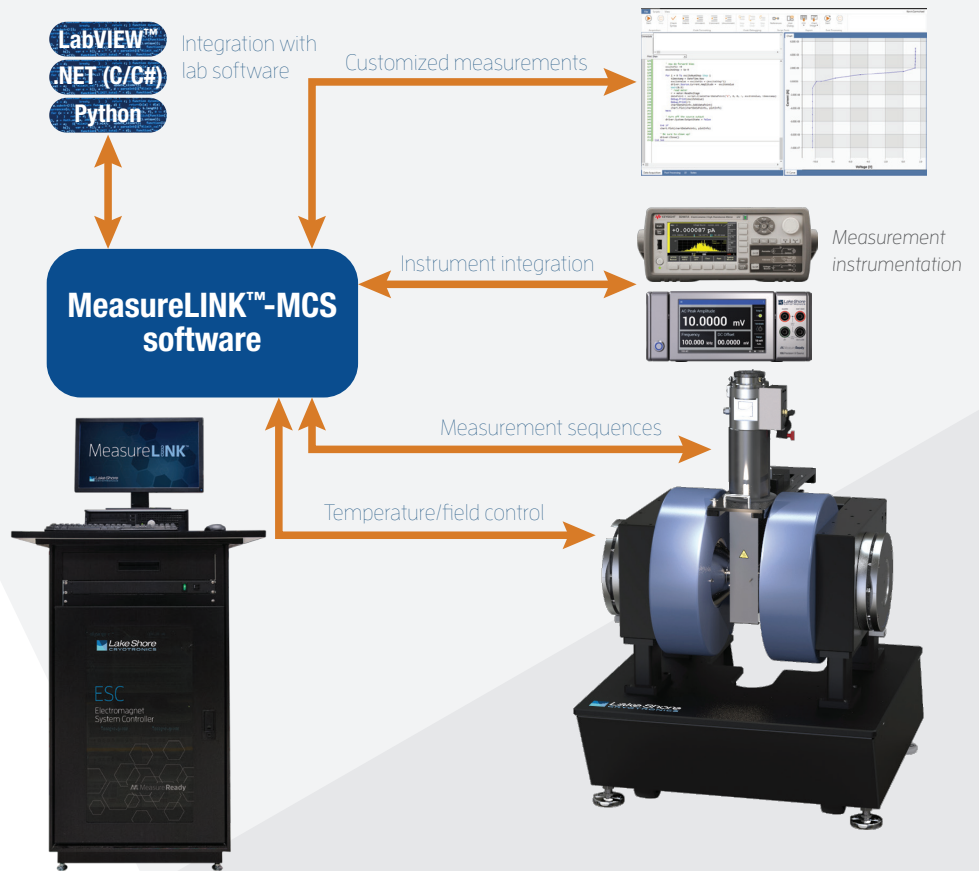
**Add MeasureLINK-MCS to any Lake Shore product or combination of products to create your own custom system, or purchase one of our ready-made combos for your application.**

MeasureLINK-MCS software is the key component of each Lake Shore system. It facilitates field control, temperature control, measurement sequencing, and integration functions.

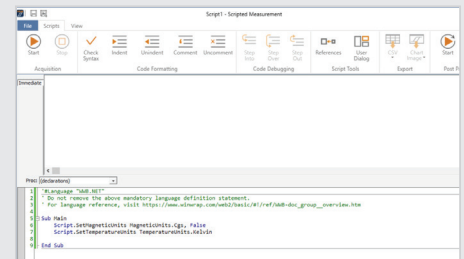
This flexible software allows the user to monitor the real-time performance of a system and to construct measurement sequences from a set of predefined controls. The menu-driven graphical user interface (GUI) provides the ability to control field and temperature to a specific setpoint or to loop these parameters through a range of settings with a specified step value. The sequences can be saved and recalled for use in repeated measurements.

MeasureLINK-MCS software features

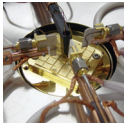
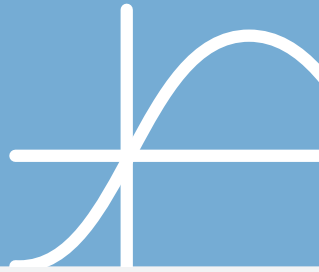
- Temperature and field control
- Measurement sequences
- Integrate Lake Shore or third-party instruments
- Integration with other lab software
- Custom measurements with scripting



**Sequence screen**  
Build a sequence of steps that define the desired measurement protocol



**Script screen**  
Extend your system functionality by creating custom scripts

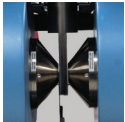


**Cryogenic Probe Stations and Systems**

Best-in-class, micro-manipulated platforms for non-destructive, on-wafer probing of device samples as a function of temperature and field using magneto-transport, DC, electro-optical, and RF/microwave measurements. Models available for probing as low as 1.6 K and in fields to more than 2 T.



*TTPX and CRX-EM-HF probe stations*

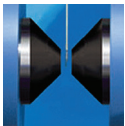


**Hall Effect Systems**

Advanced systems available in a variety of electromagnet configurations for performing Hall and magneto-transport measurements as a function of field and temperature. Available with an AC field Hall option for exploring properties of very low-mobility materials (down to 0.001 cm<sup>2</sup>/V s).

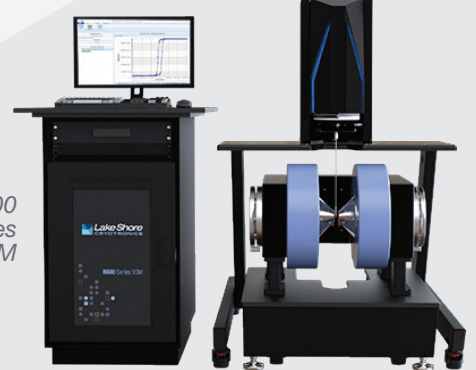


*Model 8407 Hall measurement system*

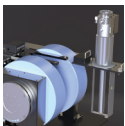


**Vibrating Sample Magnetometer Systems**

Optimized for characterizing DC magnetic properties of a broad range of sample materials, these magnetometer systems offer high sensitivity, accuracy, and speed, as well as a wide temperature-dependence measurement range (4.2 K to 1,273 K) and variable fields to 3.62 T. Featuring support for first-order-reversal-curve (FORC) measurements and analysis.

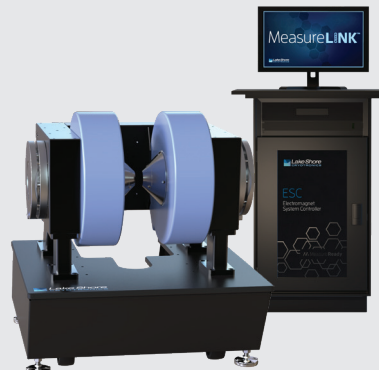


*8600 Series VSM*



**Modular Characterization Systems**

The multi-purpose MCS-EMP electromagnet platform provides all of the essential components required for automated, variable field experiments. Each MCS-EMP builds on a 4-inch or 7-inch electromagnet with pole caps, magnet base, and pedestal. Magnets feature ExactGAP™ precision-settable sample gaps. 2-inch pole caps are standard on the 4-inch MCS-EMP, and convertible 4-inch/2-inch caps are standard on the 7-inch MCS-EMP. Optical access is optional.



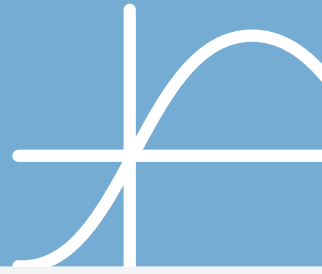
*MCS-EMP modular characterization system*

**Also available:** Electromagnet and superconducting magnet power supplies



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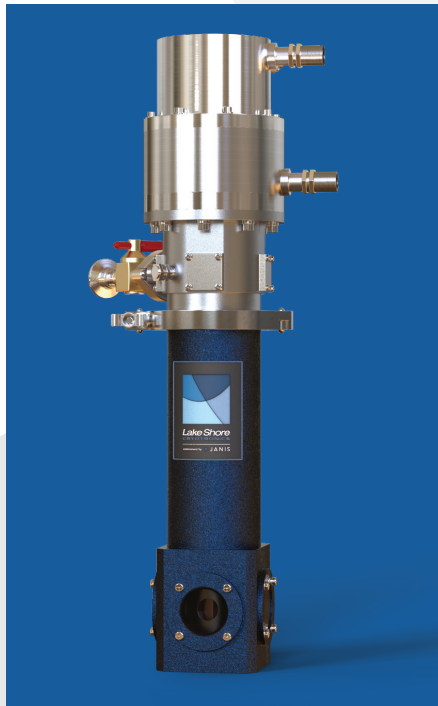
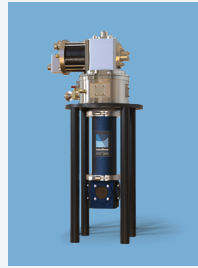
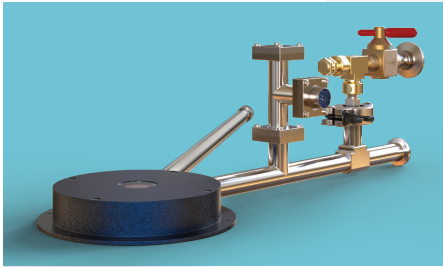
## Cryostats for spectroscopy and electrical measurements

Lake Shore Cryotronics offers a comprehensive range of cryostat products specifically designed for spectroscopic measurements. Cooled by liquid helium, liquid nitrogen, or a closed-cycle refrigerator (CCR), a cryostat is available for most spectrometer-based applications. In addition, electrical access and sample holders add the capability for resistivity and Hall measurements and other electrically-based techniques.

Solutions include LHe-cooled continuous flow and reservoir cryostats, LN<sub>2</sub>-cooled pourfill systems, and 1.5 K, 4 K, and 10 K closed-cycle refrigerators.

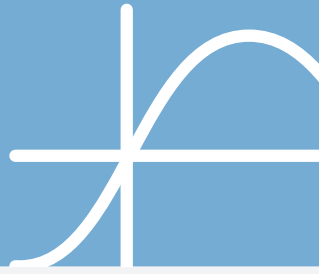
### Typical applications:

- FTIR
- ESR
- Optical microscopy
- Mössbauer
- NMR
- VSM
- UV/VIS/NIR
- Hall measurements
- Matrix isolation
- Neutron scattering
- X-ray diffraction
- Nanoscale measurements



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## Cryogen-free DryMag superconducting magnet systems

Available for optical and non-optical applications, these systems are offered in both room temperature bore configurations and variable temperature integrated configurations for operation from below 2 K to 300 K. Non-optical systems are also offered with vertical room temperature bore tubes, along with a top-loading cryogen-free cryostat for operation between 1.5 K and 300 K or higher. The magnets are typically cooled through reliable Gifford McMahon or pulse tube coolers for lower vibrations. The independent variable temperature cryostats can also be used separately for ultimate convenience.

*DryMag 1.5 K measurement system*



## Superconducting magnet systems

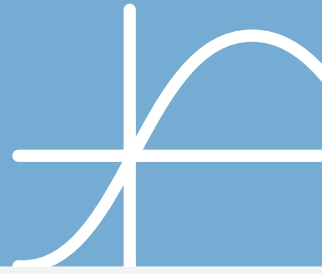
These systems feature designs that fully integrate the cryostat, magnet, automatic temperature controller and magnet power supply, complemented by a complete line of ancillary equipment.

Our renowned SuperVariMag, OptiMag, and SuperOptiMag systems offer temperatures between 1.5 K and 325 K (with options to 475 K or higher), and can be supplied with or without optical access. Our NbTi systems offer magnetic fields between 5 and 9 T with optional Lambda point refrigerators for reaching higher fields, while our Nb<sub>3</sub>Sn magnets offer fields of 17 T and beyond.



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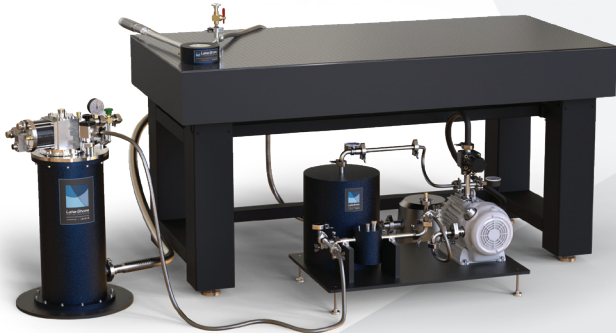


## Recirculating gas coolers

The RGC4 is an ultra-stable cryogenic microscopy platform, cooling samples and devices to 4 K without the use of liquid helium. A closed loop of helium gas is cooled by a low-vibration pulse-tube cryocooler. The cold helium gas travels to the cryostat through a flexible vacuum insulated transfer line. The gas cools the cryostat's sample mount heat exchanger, vacuum mounted sample, and thermal radiation shield before returning to the cryocooler for continuous recirculation.

- All the flexibility and convenience of a continuous flow cryostat without liquid helium
- Fast sample change without warming up the cooler
- Excellent thermal performance
- Low vibration — data available upon request
- Compatible with most existing SuperTran cryostats
- Order a new cryostat with a transfer line and choose to operate using LN<sub>2</sub>, LHe, or cryogen-free

Typical applications include micro-PL, micro-Raman, and high spacial resolution imaging.



## Custom-engineered cryogenic systems

In addition to our complete line of laboratory cryogenic equipment, Lake Shore offers a wide range of custom system design capabilities. With in-house computing facilities and computerized design and manufacturing capabilities, our experienced physicists and engineers are readily available to discuss your special requirements for any type of cryogenic application, including:

- Cryogenic cold traps with single or multiple chambers for adsorption of noble gases, oxygen, nitrogen, carbon dioxide, etc.
- Cryogenic probe stations with custom options including large (8-inch) wafer probing, automated probing, or high voltage capability
- Ultra-high vacuum compatible cryostats with optional pressure testing
- Special vibration-isolated systems for microscopy applications
- Specialty cryostats for applications such as tensile testing or cooling high-pressure diamond anvil cells

Each system is fully integrated and tested before shipping.

## Our Woburn, MA office

Janis Research  
225 Wildwood Avenue  
Woburn, MA 01801-2025  
781-491-0888

Visit [www.lakeshore.com](http://www.lakeshore.com) for:

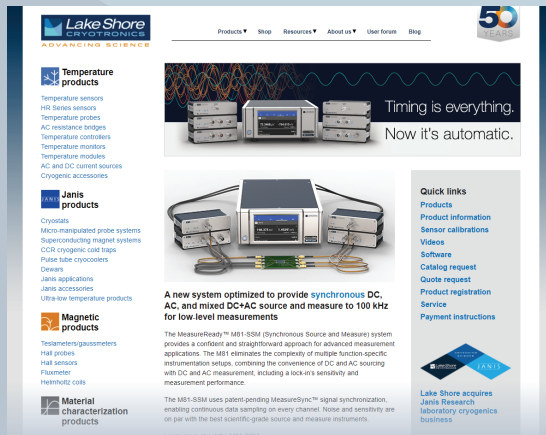
- Product user manuals and documentation
- Software, firmware updates, and drivers
- Application and technical notes
- Product demonstration videos
- CAD model files for sensors
- Sensor calibrations and installation instructions
- RFQ and pricing information
- Quality control and ISO documentation
- RoHS and other compliance documents
- Terms and conditions
- Warranty information
- Shipping information
- Sales contact information
- Repair services information
- On-demand webinars
- Press releases
- Contact info and directions to our US offices

Call or e-mail us about:

- Post-sales technical support
- Custom product design and configuration services
- System integration and engineering services
- Application support from our staff of scientists
- Extensive temperature sensor calibration services
- Expedited recalibration for magnetic instruments and probes

**World-class thermometry calibration services**

Temperature sensors either follow a known standard response within a given tolerance or they must be calibrated against known standards. Our precision calibration facilities include dilution refrigerators for ultra-low temperature calibration to 0.005 K and high temperature capability to 900 K. We use temperature standards traceable to the National Institute of Standards and Testing (NIST) in the U.S., the National Physical Laboratory (NPL) in the U.K, and the Physikalisch-Technische Bundesanstalt (PTB) in Germany. Working standard thermometers are calibrated against, and routinely intercompared with, these secondary standards along with a nuclear orientation thermometer and superconducting fixed points sets. All sensors can be calibrated over their various pre-defined temperature ranges, and calibrations include a full report with supporting electronics files, allowing easy integration of the sensor's calibration with Lake Shore's instrumentation or the customer's own data acquisition equipment.



**Questions? Answers?**

Visit <http://forums.lakeshore.com/> and become part of the conversation!

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